Decoding Global Markets:
A Self-Directed Journey into Systematic Macro Investing

Saxon Lee

9th of September 2024

Abstract

This paper outlines my attempt to create a hybrid macro model in Python, designed for forecasting key economic variables, conducting scenario analysis, and assessing debt sustainability across G4 economies (UK, US, Japan, and Euro Area). The model primarily employs Vector Error Correction Model (VECM) methodologies. This project was undertaken as a personal initiative to gain practical experience in quantitative finance and systematic macro investing. It represents a dedicated effort to address what my friends would call a "skill issue" in an unfamiliar domain and to build foundational knowledge in an area of quantitative investing not previously encountered in professional internships. The objective is to outline the model's architecture, its theoretical underpinnings informed by relevant literature, its potential applications in a trading context, and the transferable skills acquired through its development. The code for this model will stay in a private Github repo for the time being.

1 Introduction

The world of quantitative finance is ever-evolving, demanding a continuous pursuit of knowledge and practical skill. This paper documents a personal project: the construction of a hybrid structure macro-financial model. The primary motivation behind this undertaking was a desire to delve into the realm of quantitative macroeconomic analysis and systematic macro investing, areas in which I previously had limited exposure. Having not encountered macro-focused roles during prior investment internships, this project served as a self-directed learning opportunity—an attempt to, as the saying goes, 'learn to walk before I can run'. It's an endeavour to bridge a knowledge gap and tackle the challenge of acquiring new, complex skills head-on.

The model itself is developed in Python and focuses on the G4 economies: the United Kingdom, the United States, Japan, and the Euro Area. It aims to provide a framework for:

- Forecasting a suite of key financial and macroeconomic variables (e.g., GDP growth, inflation, interest rates, unemployment).
- Implementing scenario analysis to understand the potential impact of various economic shocks.
- Extending the core model to include an analysis of debt sustainability.

This paper will outline the model's architecture, discuss the theoretical foundations drawing upon established literature, explore its potential utility in a trading environment, and reflect on the transferable skills gained. It is hoped that this account provides a transparent view of a learning process in a sophisticated area of finance.

2 Model Framework and Theoretical Underpinnings

The model is designed to be hybrid in nature, i.e. it combines theoretically informed relationships with empirically estimated dynamics. The choice of Python as the development language was driven by its extensive libraries for data analysis, econometrics, and visualisation, making it a practical tool for such a project (Kelliher, 2022).

2.1 Data Acquisition and Preparation

A robust model requires reliable data. The initial phase involved sourcing time series data for the G4 economies, covering variables such as real GDP growth, CPI inflation, unemployment rates, short-term and long-term interest rates, key equity indices, exchange rates, government debt-to-GDP ratios, and fiscal balances. Data can be primarily sourced from publicly available databases like the Federal Reserve Economic Data (FRED), Eurostat, the Bank of England, the Bank of Japan, and financial data providers such as Yahoo Finance, accessed programmatically using Python libraries like 'pandas-datareader' and 'yfinance'.

Data preparation is a critical step. This involved cleaning (handling missing values, addressing outliers), transformation (e.g., calculating growth rates, taking logarithms), and ensuring consistency in frequency (typically quarterly for macroeconomic variables). A crucial part of this stage, particularly for Error Correction Models, is testing for the stationarity of time series using tests like the Augmented Dickey-Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. Non-stationary variables often require differencing to achieve stationarity, a common practice in time series econometrics (Kelliher, 2022, Ch. 3).

2.2 Econometric Methodology: Error Correction Models

The core econometric engine of the model is the Error Correction Model (ECM) or, for multivariate systems, the Vector Error Correction Model (VECM). These models are particularly well-suited for analysing relationships between non-stationary time series that are cointegrated. Cointegration implies that while individual series may wander over time (i.e., be I(1)), a linear combination of them is stationary (I(0)), suggesting a stable long-run equilibrium relationship.

The ECM framework allows for the modelling of both this long-run equilibrium and the short-run dynamics by which variables adjust towards this equilibrium. The general form of an ECM captures how deviations from the long-run relationship in one period are "corrected" in subsequent periods. The 'statsmodels' library in Python provides the necessary tools for estimating these models, including Johansen tests for cointegration and VECM estimation (Kelliher, 2022, Ch. 3). The selection of appropriate lag lengths and the validation of model assumptions (e.g., residual analysis) are integral parts of this process.

2.3 Forecasting and Scenario Analysis

Once estimated and validated, the VECMs are used to generate out-of-sample forecasts for the endogenous variables. These forecasts provide a baseline outlook for the G4 economies based on the historical relationships captured by the model.

Beyond baseline forecasts, a significant utility of such a model lies in scenario analysis. This involves defining plausible shocks to key variables (e.g., an unexpected rise in policy interest rates, a sharp decline in global growth, or a significant fiscal stimulus package) and simulating their impact on the economic paths of the G4 nations. The design and calibration of these scenarios can be informed by various frameworks. For instance, understanding policymakers' material constraints, as discussed by Papic (2020), can help in assessing the likelihood and nature of policy responses to shocks. Similarly, the influence of prevailing economic narratives, as highlighted by

Shiller (2019), can shape the transmission of shocks through an economy by affecting consumer and business sentiment.

2.4 Debt Sustainability Module

Given the current global macroeconomic landscape, an extension to analyse debt sustainability was deemed particularly relevant. This module focuses on forecasting government debt-to-GDP ratios under the baseline and alternative scenarios. The dynamics of debt accumulation are influenced by GDP growth, interest rates, and primary fiscal balances, all of which are variables within or can be linked to the core model.

The analysis draws conceptual insights from works such as Dalio (2018), which provides a comprehensive study of big debt crises and the mechanics of deleveraging. By simulating debt trajectories under various stress scenarios (e.g., prolonged low growth, sharp interest rate hikes), the model can help identify potential vulnerabilities and the sensitivity of debt paths to different economic conditions.

3 Application in a Trading Environment

While this model has been developed as a personal learning tool, the principles and outputs of such a system can find application in a professional trading environment. It is not intended for high-frequency trading signals but rather to inform medium-to-long-term macroeconomic views and strategic positioning. Potential uses include:

- **Informing Macro Views:** Providing a quantitative framework to structure and test macroeconomic theses.
- **Generating Trade Ideas:** Identifying potential mispricings or opportunities arising from divergent economic outlooks or scenario impacts across countries.
- **Risk Management:** Helping to understand the potential impact of macroeconomic shocks on portfolios.
- **Scenario Planning:** Assessing portfolio resilience under different plausible economic futures.

Such a model could be of particular use to Global Macro desks, Fixed Income and FX strategy teams, and sovereign risk analysts. The insights derived from systematic analysis, as often discussed by seasoned traders (Drobny, 2006), can complement discretionary views. It is also crucial to acknowledge the limitations of any model. The financial markets are complex adaptive systems, and concepts such as reflexivity, where market participants' perceptions can influence the fundamentals (Soros, 2003), mean that models are simplifications and their outputs must be interpreted with critical judgment.

4 Transferable Skills and Future Development

This project has been an invaluable exercise in skill development. Key transferable skills acquired or significantly enhanced include:

- **Quantitative Analysis:** Applying econometric techniques to real-world data.
- **Python Programming:** Proficient use of 'pandas' for data manipulation, 'statsmodels' and 'scipy' for statistical modelling, and 'matplotlib'/'seaborn'/'plotly' for data visualisation.
- **Econometric Modelling:** Deepened understanding of time series analysis, particularly ECM/VECM frameworks, including model specification, estimation, and diagnostics.

- **Data Management:** Experience in sourcing, cleaning, and preparing complex datasets for analysis.
- **Critical Thinking:** Developing the ability to interpret model outputs, understand limitations, and synthesise information from various sources.

Future development of this model could involve several avenues: incorporating more granular data (e.g., sectoral data), refining model specifications with alternative theoretical priors, exploring non-linear relationships, integrating machine learning techniques for specific components (e.g., nowcasting or sentiment analysis), or expanding the geographical scope.

It is important to state that the complete Python codebase for this project, which includes further functionalities, specific calibrations, and visualisation dashboards beyond the general outline provided in this paper, may be kept private. This decision is made considering its potential applicability and value as a demonstration of practical skills in professional environments I aspire to join.

5 Conclusion

The development of this hybrid structure macro-financial model has been a challenging yet immensely rewarding personal undertaking. It represents a deliberate effort to step outside a familiar comfort zone and engage deeply with the principles and practices of quantitative macroeconomic analysis and systematic investing. While the journey to master this field is ongoing, this project has laid a solid foundation, enhanced critical skills, and provided a tangible output that demonstrates a commitment to continuous learning and tackling the "skill issue" head-on. The insights gained from building this model, from grappling with data intricacies to interpreting complex outputs, are invaluable for anyone aspiring to a career in quantitative finance.

References

- Dalio, R. (2018). *Principles for Navigating Big Debt Crises.* Bridgewater Associates.
- Drobny, S. (2006). *Inside the House of Money: Top Hedge Fund Traders on Profiting in the Global Markets.* John Wiley & Sons.
- Kelliher, C. (2022). *Quantitative Finance With Python: A Practical Guide to Investment Management, Trading, and Financial Engineering.* Chapman & Hall/CRC Financial Mathematics Series.
- Papic, M. (2020). *Geopolitical Alpha: An Investment Framework for Predicting the Future.* Wiley.
- Shiller, R. J. (2019). *Narrative Economics: How Stories Go Viral and Drive Major Economic Events.* Princeton University Press.
- Soros, G. (2003). *The Alchemy of Finance.* John Wiley & Sons. (Original work published 1987).